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Market evaluation bioactives potato rest streams

Final presentation 25 January 2013

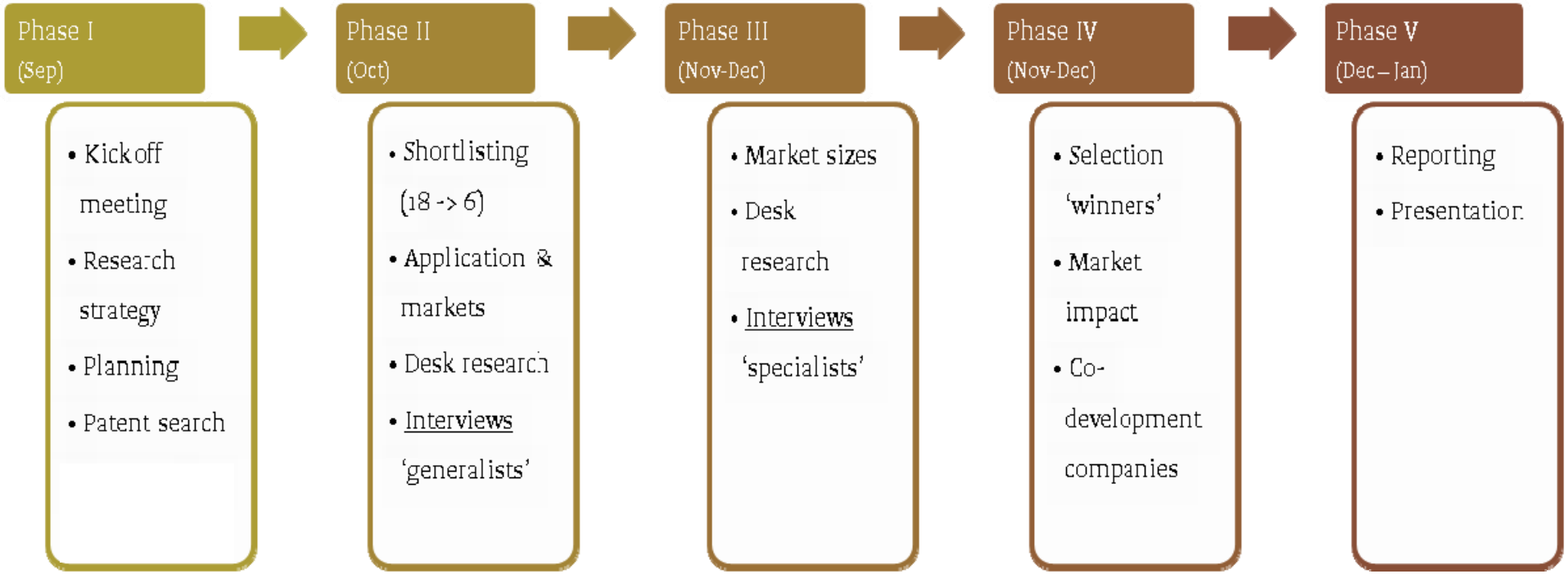
Market evaluation bioactives potato reststreams

Overall goals quick scan

1. Identify high added value ‘lead’ bioactives from potato reststreams
2. Identify and characterise applications and new markets
3. Identify target companies for lead co-development

Market evaluation bioactives potato reststreams

Overall approach



Market evaluation bioactives potato rest streams

Starting materials

Enzymes / enzyme fractions		Peptides	
1	Lipases	11	Native peptides in deproteinated potato juice
2	Phospholipases	12	ACE inhibitors
3	Pectine methylesterase	13	Ceramide synthesis stimulating peptides
4	Apyrase (ATPase)	Others	
5	Lipoxygenase	14	Pectinates
6	Polyphenol oxidase	15	Amino acid concentrates
Enzyme inhibitors		16	Soup basis with amino acids and minerals
7	Protease inhibitor	17	Glycoalkaloides / solanine
8	Chymotrypsin inhibitor	18	Chlorogenic acid derivates
9	Blastase inhibitor	19	Other
10	Satiety enhancer via PI-2		

Market evaluation bioactives potato rest streams

Starting materials

- More or less purified fractions
- Some bioactives already in use in existing products
- Some fractions/applications are already (currently being) patented
- Not and/and; sometimes either/or

Results phase II

Overall conclusions interviews generalists (1)

- Protein recovery agro rest streams ‘necessity’ (economy/energy/society)
- Interviews (and literature data) provide several interesting applications
- Possibilities for low – medium – high added value applications
- Higher anticipated added value bio-active implies:
  - Higher development costs
  - Appropriate more stringent regulatory environment: higher market entry barriers
  - Smaller market volumes in weight
  - Non-GMO less of an advantage

Results phase II

Overall conclusions interviews generalists (2)

- Bioactive markets volatile:
  - Existing GMO and non-GMO production platforms
    - Protein producers cherry pick interesting proteins
    - Tailor made production of bioactives (pH, temperature optimum) possible (Codexis, Mexigen)
- 'Potato processing industry should focus on *limited number* of bioactives':
  - High concentration or activity
  - Easy purification (if done by potato processing industry itself)
  - High added value
  - Remaining proteins / bioactives for food & feed use

Results phase II

Overall conclusions interviews generalists (3)

- ‘Potato processing industry use the complexity of the fruit juice’:
  - Also consider new products: meat replacer, potato milk, etc
- ‘Potato processing industry not to enter new product/new market combinations without acquiring proper external competences or marketing channels’
- ‘Non-GMO advantage primarily relevant for the food sector’
- Patent search: limited patenting; Freedom to operate

Results phase II

SWOT analysis

S	W	O	T
• Non-GMO • Non-allergenic • Native bio-actives • Food grade environment • Economy of scale • Functional value • Nutritional value • Potentially low cost raw material and production	• Juice unstable, partly defined, complex • DSP complex; required purity possible? • Protein engineering is not possible • high added value applications demand for complex development and high investments • Limited experience in other markets • Limited product range: difficult to address varying customer demands	• Breeding new potato varieties • New products (eg. potato milk, meat etc) • Open innovation with specialized companies	• Novel food act • Alternative production platforms (with optimized processes and products) • Cherry picking enzyme producers • Customized production platforms • Low market prices for some enzymes • Loosing interest of shareholders due to unfamiliar activities

Results phase II

Current protein-based products potato rest streams

- Egg replacer in vegetarian products and meat replacers
- Product for paté (caseinate replacer)
- Product for protein containing sports drinks, bars and gels
- Product for vegetarian ice cream & sorbet ice
- Product for vegetarian whipped cream
- Product for appetite suppression
- gluten free products
- Meringues (bakery)
- Mayonnaises (dressings)
- Wine clarification
- Bread improvers

Enzymes / enzyme fractions

Enzymes / enzyme fractions		Literature / internet	Literature / internet	Generalist 1	Generalist 2	Generalist 3
		Activity	Industrial use	Applications	Applications	Applications
1	**Lipases**	Converting insoluble triacylglycerols in (more) soluble fatty acids and monoacyloglycerols	Manufaturing cheese & cheese flavors, dairy & bakery products, flavors	Several patatines known; temperature optimum potato lipase 30C (?); likely lower than lipases in washing powders en dough	Many lipases on the market; Specificity must be unique [Heineken in beer brewing?]	Lipase crystals for humane turned out to be not succesful in a US based company
2	**Phospholipases**	Hydrolysis of phospholipids into fatty acids and lipophilic substances	Vegetable oil degumming, bread making, egg yolk industry	Specificity?	For use in the dairy industry. NB non-GMO (!)	
3	**Pectine methylesterase**	De-esterify pectines effecting gelling properties	Degradation of pectin: fruit and vegetable juice manucturing, pulp treatment, liquefaction, maceration,	To modify pectines; eg gelating appels, peers. Pectine methylesterase (PME) is used by DSM.	Many DME's commercially available (Genencor, Novozyme); potato processing industry most likely too small source and does not deliver specific blends of enzymes	
4	**Apyrase (ATPase)**	Ca-activated plasma membrane-bound phosphorylase that catalyses the hydrolysis of ATP to yield AMP and inorganic phosphate.	Prevention ischemia-reperfusion, treatment of myocardial infarction, luciferase-based microbial contamination tests to clear samples of background ATP	Many types available; for human medical application human phosphatases produced with plant / microbial production systems available. Even with optimized pH and temperature	Expensive enzyme; price based on sales in small quantities only; potato processing industry may not even reach 10% of that price	
5	**Lipoxygenase**	Catalyse the dioxygenation of methylene-interrupted pentadiene fatty acids to fatty acids	Bleaching of carotenes and chlorophyl; loss of quality of unblanched frozen vegatables (rancidity); improving dough elasticity, imparting odors and flavors to fresh fruit and vegetables	Limited applications in the flavour industry; niche markt. Tricishexenal lipoxygenase		
6	**Polyphenol oxidase**	Acts on monohydroxyphenol, 0-dihyddroxyphenols and p-dihydroxycompounds	Deteriorate (browning) of food and vegetables. Color development in processing of tea, coffee, cocoa, apple cider, prunes, black raisins, figs, zapote	Unwanted enzyme following its inhibiting properties; maybe interesting as inhibitor?		

Enzyme inhibitors

Enzyme inhibitors		Literature / internet	Literature / internet	Generalist 1	Generalist 2	Generalist 3
		Activity	Industrial use	Applications	Applications	Applications
7	**Protease inhibitor**	inhiting/preventing proteolysis	preventing proteolyse in bakery, brewing, cereals, cheese production, chocolate/cacoa fermentation, feed conversion, fish flavour formation, legume flavor removal, meat tenderization, milk coagulation, wine clarification **?????**	Niche market	Most likely very interesting for potato processing industry to elongate the shelf life of food products; may not interfere with intestinal digestion of food. Dosing of extreme importance due to potential toxicity. Perhaps governmental regulation required	
8	**Chymotrypsin inhibitor**			Niche market	idem	
9	**Elastase inhibitor**	Inhiting elastase activity	Reduce inflammation and fibrosis	Niche market	idem	
10	**Satiety enhancer via PI-2**	17-18% energy reduction			Most likely interesting for potato processing industry ; effective amino acid sequences must be kept confidential (!)	

Peptides

Peptides		Literature / internet	Literature / internet	Generalist 1	Generalist 2	Generalist 3
		Activity	Industrial use	Applications	Applications	Applications
11	**Native peptides in deproteinated potato juice**	Minerals and organic acids including amino acids, glutamate				
12	**ACE inhibitors**	Angiotensin-converting-enzyme inhibitor: pharmaceutical application for the treatment of hypertension (high blood pressure) and congestive heart failure		Many ACE inhibitors commercially available		Obtained from milk
13	**Ceramide synthesis stimulating peptides**	Ceramides: lipid molecules composed of sphingosine and a fatty acid. Peptides act via onset of genes		Lipides; for use in the cosmetics industry; produced by DSM spin off. Niche market		

Others

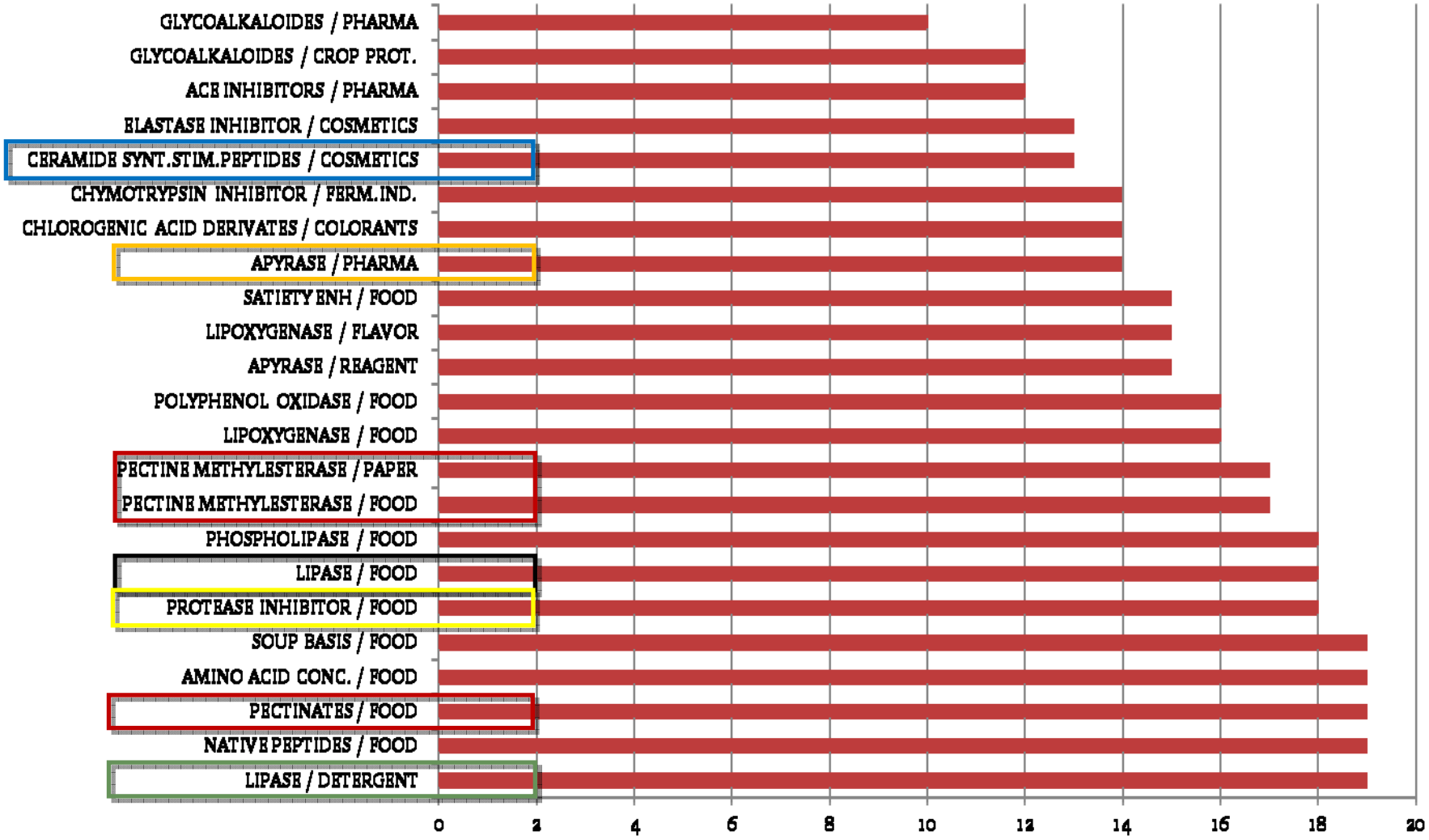
Others		Literature / internet	Literature / internet	Generalist 1	Generalist 2	Generalist 3
		Activity	Industrial use	Applications	Applications	Applications
14	**Pectinates**			How unique are the pectinates; there are many of them..		
15	**Amino acid concentrates**			Interesting if essential amino acids; eg methionine	Limited economic relevance; only to get rid of rest streams. Application in synthesis of platform chemicals	
16	**Soup basis with amino acids and minerals**				Idem	
17	**Glycoalkaloides / solanine**	Better than plant sterols; Solanine has fungicidal and pesticidal properties, and it is one of the plant's natural defenses. Sterols for sex hormone synthesis. Anticancer compounds			Base chemical solanine not very interesting in view of the complex synthese of steroid hormones from solanine	
18	**Chlorogenic acid derivates**					
19	**Other**	Patatine as antioxidant, antimicrobial or antiinflammatory agent; IGF-1 like activity in piglets of fermented potato protein;				

Qualitative ranking criteria

	1	2	3
Estimated market size (€)	Niche	Medium	Large
Potential added value	Low	Medium	High
Required investments	High	Medium	Low
Non-GMO advantage	No	Not evident	Yes
History, competences / market access available	No	Partly	Yes
Time to market	Long	Medium	Short
Technological development / legislative hurdles	Extensive	Medium	Limited

		Applicable sector(s)	Current market size (€)	Added value	Invest-ments	Non-GMO advantage		Time to market	Hurdles	Score
1	Lipases	Food	3	2	2	3		3	2	18
1	Lipases	Detergent	3	2	3	2		3	3	19
2	Phospholipases	Food	3	2	2	3		3	2	18
3	Pectine methylesterase	Food	3	2	2	3		2	2	17
		Paper	2	2	3	2		2	3	17
4	Apyrase (ATPase)	Pharma	3	3	2	2		1	2	14
4	Apyrase (ATPase)	Reagents	2	2	2	2		2	2	15
5	Lipoxygenase	Food	1	2	3	3		2	2	16
		Flavor	1	2	2	3		2	2	15
6	Polyphenol oxidase	Food	1	2	3	3		2	2	**16**
7	Protease inhibitor	Food	2	2	3	3		3	2	18
8	Chymotrypsin inhibitor	Ferm.ind.	2	1	2	2		3	2	14
9	Elastase inhibitor	Cosmetics	2	3	1	2		2	1	13
10	Satiety enhancer via PI-2	Food	2	3	2	3		1	1	15
11	Native peptides in deproteinated potato juice	Food	2	2	3	3		3	3	19
12	ACE inhibitors	Pharma	3	3	1	2		1	1	12
13	Ceramide synthesis stimulating peptides	Cosmetics	2	3	1	2		2	1	13
14	Pectinates	Food	3	2	3	3		3	2	19
15	Amino acid concentrates	Food	3	2	3	3		3	2	19
16	Soup basis with amino acids and minerals	Food	3	2	3	3		3	2	19
17	Glycoalkaloides / solanine	Crop protect	2	3	1	2		1	1	12
		Pharma (?)	3	3	1			1	1	10
18	Chlorogenic acid derivates	Colorants	2	2	2	2		2	2	14

Ranking


GLYCOALKALOIDES / PHARMA
GLYCOALKALOIDES / CROP PROT.
ACE INHIBITORS / PHARMA
ELASTASE INHIBITOR / COSMETICS
CERAMIDE SYNT.STIM.PEPTIDES / COSMETICS
CHYMOTRYPSIN INHIBITOR / FERM.IND.
CHLOROGENIC ACID DERIVATES / COLORANTS
APYRASE / PHARMA
SATIETY ENH / FOOD
LIPOXYGENASE / FLAVOR
APYRASE / REAGENT
POLYPHENOL OXIDASE / FOOD
LIPOXYGENASE / FOOD
PECTINE METHYLESTERASE / PAPER
PECTINE METHYLESTERASE / FOOD
PHOSPHOLIPASE / FOOD
LIPASE / FOOD
PROTEASE INHIBITOR / FOOD
SOUP BASIS / FOOD
AMINO ACID CONC. / FOOD
PECTINATES / FOOD
NATIVE PEPTIDES / FOOD
LIPASE / DETERGENT
0
2
4
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16
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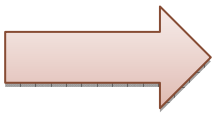
20

Phase III-IV

Interviews specialists

Selection for phase III-IV	Application
Lipases	**Detergent**
Lipases	**Food**
Pectinates & pectine methyl esterases	**Food, paper**
Apyrase	**Pharma**
Protease inhibitors	**Food**
Ceramide synthesis stimulating peptides	**Cosmetics**



6 confidential meetings with specialists

Phase III-IV: Key findings interviews experts

Overall conclusions interviews experts

Interesting opportunities for the potential applications:

- Several advantages over current situations, even new products possible
- Codevelopment possible for the majority of potential applications
- Most potential applications however have their specific points of attentions

Phase III-IV: key data

Volumes and sizes

		1	2	3
B	Estimated development costs	> 10 mio €	10-1 mio €	< 1 mio €
C	Estimated price (€/kg)	< 10 €/kg	10 - 100 €/kg	> 100 €/kg
D	Estimated market size (t.p.a.)	< 1 t.p.a.	1 – 10 t.p.a.	> 10 t.p.a.
E	Estimated market size (€ p.a.)	< 1 M€ p.a.	1 K€ – 3 M€ p.a.	> 3 M€ p.a.

Phase III-IV: key data

Volumes and sizes

			Estimated development costs	Estimated costs	Estimated market size (t.p.a.)	Estimated market size (€)
	See sheet 20► Bioactive (fraction) ▼		B	C	D	E
1	Lipases	detergent	2	1 / 2	3	3
2	Lipases	food	2	2	3	3
3	Pectine metylesterase	food	3	3	3	2
4	Apyrase (ATPase) (up to phase II)	pharma	3	3	1	3
5	Protease inhibitors	food	3	1	3	3
6	Ceramide synthesis stimulating peptides	cosmetics	2	3	2	3

Phase III-IV: key data

Others aspects

			USP	Connection in the chain	Contributio potato processing industry further development	Netherlands co-developent companies	Possible product applications
	See sheet 20 ► Bioactive (fraction) ▼		B	C	D	E	
1	Lipases .	Detergent	• No off-flavors • (Stereo) Specifity • Stable	RM/IP	Purification Granulation	Unilever	Liquid detergents
2	Lipases	Food	• Specifity • Functionality: ?	RM	Purification	DSM (Valio)	Dairy products
3	Pectine metylesterase	Food	• Plant PME better properties than yeast PME	IP	Purification and product placement	Heinz, Unilever, DSM	(Intrafruit) gelling agent
4	Apyrase (ATPase) (up to phase II)	Pharma	• Inhibitor inflamma-tion (POP!)	RM	Purification	BAC BV, CRO's, AMRIF	Topical and oral medicines
5	Protease inhibitors	food	• Unique spectrum of protease inhibitors	IP	Application R&D	(Fresh) food companies DSM, SkinTec	Shell life improver; anti skin irritant
6	Ceramide synthesis stimulating peptides	Cos-metics	• No competition: new concept • green cosmetic (?)	RM	Purification	DSM, BASF, Evonik	cosmetics

Phase V

New product applications

Selection for phase III-IV	Market	Application
Lipases	**Detergent**	•Liquid detergents •Specific combination with protease inhibitor
Lipases	**Food**	•New dairy products
Pectine methyl esterases	**Food**	•PME in (halva) jams and spreads •Texture improvement in fruits & vegetables in, e.g., spreads and pizza's after vacuum infusion of PME
Apyrase	**Pharma**	•Cream/ointment for burns, psoriasis, diabetes ulcers •Oral, slow release formulations in IBD, collitis, Crohn's disease •Oral, slow release endurance exercises
Protease inhibitors	**Food** **Pharma**	•Shelf life improvement of, e.g., meat and fish •Anti-skin irritation agent in diapers, etc.
Ceramide synthesis stimulating peptides	**Cosmetics** **Pharma**	•Cream/ointment: burns, excema, thin skin, microbial infection •Oral use: improvement gut flora (i.c.w. TNO?)

Phase V

Conclusions

- Potato reststreams bioactives provide substantial commercial potential
- Selected 6 bioactives:
  - In existing products AND for development new products
  - Opportunity for diversification: Food -> pharma / detergents / cosmetics
  - Partnering / codevelopment key to success
  - Dutch potential partners identified/interested;
  - Upfront non-capital investments required